R E P O R T R E S U M E S

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AGRICULTURAL CHEMICALS SALES AND SERVICE. AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS, MODULE NUMBER 10.

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THE PURPOSE OF THIS GUIDE IS TO ASSIST TEACHERS IN PREPARING HIGH SCHOOL OR POST-SECONDARY STUDENTS FOR EMPLOYMENT IN AGRICULTURAL CHEMICAL SALES AND SERVICE. ONE OF A SERIES OF MODULES FOR AGRICULTURAL SUPPLY OCCUPATIONS, IT WAS DEVELOPED ON THE BASIS OF DATA FROM STATE STUDIES BY A NATIONAL TASK FORCE. APPLICABLE TO TWO LEVELS OF INSTRUCTION, THE MODULE INCLUDES SECTIONS ON (1) CHEMICALS IN AGRICULTURE, (2) PEST IDENTIFICATION, (3) PESTICIDE RECOMMENDATION RESPONSIBILITY, (4) PESTICIDE APPLICATION RECOMMENDATIONS, (5) CUSTOMER ADVICE ON CHEMICAL SAFETY, (6) LABEL AND LITERATURE INTERPRETATION, AND (7) CHEMICAL MERCHANDISING METHODS. SUGGESTIONS FOR INTRODUCING THE MODULE AND EVALUATING THE EDUCATIONAL OUTCOMES, AND SOURCES OF INSTRUCTIONAL MATERIALS ARE GIVEN. EACH SECTION INCLUDES SUBJECT MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL AIDS, AND REFERENCES. THE MODULE IS DESIGNED FOR 30 HOURS OF CLASS INSTRUCTION, 6 HOURS OF LABORATORY EXPERIENCE, AND 72 HOURS OF OCCUPATIONAL EXPERIENCE. TEACHERS NEED A BACKGROUND AND STUDENTS AN OCCUPATIONAL GOAL IN THE FIELD. THIS DOCUMENT IS AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 632 - 000 644) FOR $7.00 FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212. (JM)

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AGRICULTURAL CHEMICALS SALES AND SERVICE

One of Twelve Modules in the Course Preparing for Entry in

AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS

Module No. 10

The Center for Research and Leadership Development

in Vocational and Technical Education

The Ohio State University
980 Kinnear Road
Columbus, Ohio, 43212

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DATE: August 7, 1967

RE: (Author, Title, Publisher, Date) Module No. 10, "Agricultural Chemicals - Sales and Service," The Center for Vocational and Technical Education, August, 1965.

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Appropriate School Setting High school
Type of Program General high school class in agricultural supply
Occupational Focus Job entry in retail business that sell agricultural supplies
Geographic Adaptability Nationwide
Uses of Material Instructor course planning
Users of Material Teachers

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Teacher Competency Background in agricultural supply--sales and services
Student Selection Criteria High school level, goal in agricultural supply--in the area of sales or service.
Time Allotment Estimated time listed in module. (P)

Supplemental Media --
Necessary x
Desirable
(Check Which)

Describe Suggested references given in module. (P)

Source (agency)
(address)

AGRICULTURAL CHEMICALS - SALES AND SERVICE

CONTENTS

AGRICULTURAL CHEMICALS - SALES AND SERVICE

Major Teaching Objective for a High School Course

To develop the understandings and abilities needed for initial employment as an "inside salesman" in the agricultural supply business, which includes agricultural chemicals among its sales and services.

Major Teaching Objective for a Post-High School Course

To develop the understandings and abilities needed for entry and advancement in the agricultural supply business, which includes agricultural chemicals among its sales and services.

Suggested Time Allotments

At school		
Class instruction	30	hours
Laboratory experience	6	hours
Total at school	36	hours
Occupational experience	72	hours
Total for module	108	hours

Suggestions for Introducing the Module

This module is applicable to two types of courses, the two-year high school course preparing students upon graduation for entry in the agricultural supply business which handles agricultural chemicals along with its other products, and the post-high school course preparing older, mature students for entry and advancement in the same business.

The levels of competence expected of the graduates of the two courses are different, however. At the high school level, this module is designed to help the person entering agricultural supply--sales and service occupations, understand and use readily available information to assist the customers in making their own decisions. This module should also make the student realize that he can give only limited advice since his lack of specialized training prohibits his making extensive recommendations for the selection and use of agricultural chemicals. The customer in farm supply centers usually has problems involving increasing yields, reducing costs, improving quality, and weighing the relative merits of different products. The salesperson provides service by helping the customer identify his needs and by satisfying these needs through the sale of appropriate products. However, because of the dangers of potentially poisonous chemicals and the hazards of improper use on growing plants, the level of employment for the high school graduate in sales will be that of an "inside" sales person working under the direct supervision of a manager. Consequently, the competencies to be

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developed are primarily those at the understanding and appreciation levels, not those ability levels affected by age, maturity, or necessity for detailed technical preparation.

At the post-high school level, average students will be in a position to develop the effective abilities a salesman needs who is working under much less supervision. In either case, the purpose of this module is to provide the student with the general background needed for sales and service in a agricultural supply business. It is not the purpose of this module to develop a technically trained fieldman who can make recommendations on complex problems involving agricultural chemicals. A whole course in agricultural chemical technology is needed for such preparation and has been developed by Center staff personnel.

As with all good teaching, the instructor should proceed from the "known" to the "unknown." In teaching this material, the teacher has two choices. He may start with the brand seen on the shelf and work back to basic chemical concepts, or he may begin with chemical characteristics and work toward trade names which are usually unfamiliar at first and which vary widely with the different companies. Trade names have been kept to a minimum in this module and are used only for illustrative purposes. Their use does not imply endorsement of any particular product. Whenever possibe, it is desirable to teach on a "class" basis, e.g., chlorinated hydrocarbons or organic phosphates. Concepts taught on this basis will carry over even though specific chemicals fall into disuse as newer and better ones are developed. This approach may be more appropriate for post-high school classes as experience indicates that high school students pick up different trade names when working in agricultural supply centers and learn their general uses even though the chemical background is not understood.

Discuss with the students the types of agricultural chemicals used in your area and how the farmer profits from them. Attempt to develop with them as complete as list as their experiences permit. Attempt to group these chemicals in a logical arrangement to assist the students in cataloging the various chemicals in their minds.

Agricultural chemicals, in the context of this module, includes pesticides and plant growth regulators but does not include chemical fertilizers. The sale of these materials has developed into an important phase of the operation of agricultural supply businesses. Indications are that it will continue to grow in importance.

Attempts on the part of man to "balance nature" in his favor are found in the harnessing of fire, the domestication of animals, and the growing of crops. As man began to control his environment by bringing together herds of livestock and growing large acreages of crops, he developed a condition of paradise for the insects, fungi, and other pests that lived on these animals and plants. To maintain a "balance of nature" in man's favor, he needed to combat these pests. The use of chemicals have proven to be a most effective method.

The use of chemicals in agriculture is not something new in man's arsenal of weapons in fighting disease and hunger. From the early uses of sulfur and arsenic in the control of human, livestock, and crop pests to the modern day "wonder chemical," man has been striving to find methods of adjusting the "balance of nature" to better meet his needs. Many people date the modern era of agricultural chemicals from the 1940's with the development of DDT. Since then there have been more advances in chemical warfare against man's pests then in all previous history. The development of organic phosphates, systemic insecticides, selective herbicides, sterilants, attractants, repellants, plant growth regulators, and other chemicals are all new advancements in man's attempt to control his environment.

Without the use of chemicals to control pests, man could not control the perils of disease and hunger that still prevail in many parts of the world. The World Health Organization estimates that two-thirds of the world's population still do not have enough to eat. How critical will this problem become by the year 2000 when the world's population is expected to be doubled? The increases use and development of agricultural chemicals is one of the major tools of man in his fight against weeds, insects, diseases, and other pests that limit his ability to produce food.

In the United State alone, it is estimated that two billion dollars are lost annually due to disease in livestock, five billion dollars due to weeds, and another three billion dollars due to crop insects. This totals ten billion dollars in losses to American agriculture alone with additional losses due to rodents, fungi, nematodes, and all the other types of pests that invade the farms, ranches, and warehouses of our agricultural industry.

Since the advent of DDT, the chemical industry has developed into one of the largest farm supply areas, and indications are that its growth will be at an ever increasing rate as new products are developed and the demand for food becomes more critical.

There are many persons in your community who need an understanding of agricultural chemistry. Develop a list of persons that students in your class know who need a knowledge of agricultural chemicals in their work. Develop a list of the skills, abilities, and understandings these people need concerning agricultural chemicals. Some items that should be listed are:

1. What types of chemicals are available
2. How to use chemicals safely
3. When to use chemicals
4. What chemicals to use

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5. Proper methods of application

6. Being able to read and interpret chemical labels

7. Being able to identify pests and their damages

Other items could easily be added to the above list, but these are a few of the important competencies that will need to be understood. At this time, the teacher can emphasize that the high school student entering an agricultural supply business upon graduation from high school cannot possibly become proficient in all of the areas revealed by this list.

The field of agricultural chemicals is so broad and changes so rapidly that this module will need to deal only with broad understandings and principles that are characteristic of many chemicals. It does not attempt to discuss the use of individual products that vary from area to area and year to year.

This module will need to be supplemented with current information from the U. S. D. A., your state land grant college, and commercial concerns.

Competencies to be Developed

I. To appreciate the importance of agricultural chemicals in modern agriculture

Teacher Preparation

Subject Matter Content

The value of agricultural chemicals cannot be put in terms of dollars. It is difficult to measure the additional production we derive from the use of chemicals and more difficult yet, to determine the amount of production lost by inadequate or improper use of chemicals. Use of chemicals assists us in protecting our harvest while in storage. Large amounts of food and fiber are still lost by failure to use adequate amounts of chemicals. Even more important, how do you measure the lives of thousands of the world's starving people lost daily because chemicals were not used or not used effectively?

The following figures should startle and arouse an interest in agricultural chemicals among your students.

1. By the year 1975 the United States population will increase by approximately 50 million people. This will require 47 billion more pounds of milk, 16 billion more pounds of meat, 20 billion more eggs and 31 million more tons of fruits and vegetables. At present levels of production this would require 200 million acres of farm land--land we don't have. Will we need chemicals to reduce the losses of food and fiber due to disease, insects, and weeds?

2. By the year 2000 we will need to produce more food on one acre than we presently produce on two acres to feed the exploding population. Will pesticides help do the job?

3. Two out of every three world citizens do not have a sufficient diet. Will man fight disease and hunger with chemicals or go to war with other men in a fight for food?

4. In Africa it is estimated that forty per cent of the harvested crops are destroyed by pests while thousands of people starve. Are we going to feed pests or people?

5. In the United States, it is estimated that rodents alone destroy enough food annually to feed the entire population of Chicago for a year. Can we continue this wastefulness?

Economic losses due to insects, diseases, weeds, and other pests are numerous and affect us as follows:

1. Reduce yields from crops

2. Reduce production from livestock

3. Lower quality of crop and livestock products

4. Destroy food and fiber in storage

5. Infest and contaminate our food and water supply

6. Reduce man's ability to work effectively

7. Increase our costs of production

8. Reduce our land values

9. Limit our crop choices

10. Damage our buildings and equipment

Specific examples of these types of economic losses are common in all communities. Tying these general types of losses to common problems in your area will make these losses more meaningful to your students.

Man's progress has been the result of his successful efforts to understand and control his environment. Had man not been blessed with this ability to bend nature to serve his needs, he might still be living in caves, the helpless victim of famine and disease.

In waging his battle for survival, man has developed pesticides designed to meet his needs and today we have no substitute for them. In America, we have developed chemical aids to the point where starvation and disease are effectively controlled. It is only in the areas of the world where these chemical tools are used that starvation and epidemic disease are not a serious daily fear.

This chemical technology has created other problems. In winning the war on disease, population and man's life span have been expanded. In India, with the aid of pesticides, the malaria cases were reduced from 75 to 5 million cases annually in ten years with the life span of man increasing from 32 years to 47 years in the same period. Each year, more mouths must be fed and more people protected from the perils of nature. Agricultural chemicals will play a major role in this effort.

While some people still abhor the use of chemicals in the production of food and fiber in our war against disease, the use of agricultural chemicals is one of our main bridges from disease and famine to plenty and peace.

There is much that can still be accomplished with the use of agricultural chemicals in the United States. Some of the important areas where chemicals can be used more effectively are:

1. Weeds, the major pest in limiting crop yields in most areas, often reduce yields by 25 per cent.

2. Ten per cent of all crops are destroyed annually by insects.

   a. Cotton insects did 900 million dollars damage in one year.

   b. Corn borer caused 350 million dollars damage in a single year.

   c. Insects cause more damage to our forests than fire.

   d. Cattle grubs alone cause two million dollars damage to cattle hides annually.

3. Stem rust has reduced our total wheat yield over 25 per cent in serious years.

These are but examples of the amount of damage that weeds, insects, and diseases can cause. It is estimated that if no control was used on the pests of man, crop and livestock production would drop to ten per cent of its present level.

The field of agricultural chemicals offers expanding opportunities for young men interested in sales and service occupations. It is a challenging, ever changing field where today's modern chemical may be as out-dated as the horse and carriage by tomorrow as chemical scientists continue their search for new, more effective, and safer chemicals to help man wage his war against disease and hunger. Because of the rapid advances being made in this area, young men entering this field will be forced to study constantly to keep up with new products and techniques in the industry.

Suggested Teaching-Learning Activities

1. Have an agricultural chemical representative discuss with the class the changes and opportunities available to young men in the industry.

2. Arrange a class trip to a firm that does considerable business in agricultural chemicals and become familiar with the types of products and services the business provides.

3. Discuss with the class the major pest problems encountered by farmers, ranchers, gardeners, home owners and others in your community.

4. Have a local farmer discuss with the class the amount and purpose of chemicals used each year.

5. Develop with the class a list of businesses in your community that deal with agricultural chemicals in some manner. Have different students interview various personnel in these businesses to determine the type of services they provide and the scope of their activities. Have the students report the results to the class.

6. Show the film strip, "Facts on Pesticides" frames 1-53.

7. Arrange a field trip to an experimental station or commercial test plot to compare chemical control versus no control on plants.

Suggested Instructional Materials and References

Instructional materials

Film strip, "Facts on Pesticides," with recording.

References

1. Agricultural Chemicals, pp. 7-15, 19-28.

2. Agriculture in Our Lives, pp. 355-360, 509-510, 542-544, 571-574.

Suggested Occupational Experience

Have the student develop a small test plot with a crop highly susceptible to damage by pests of all types. Use no chemical controls on a portion of the plot and recommended controls on the remainder. Have the students continue to observe the plots and note the advantages of the chemicals used. This plot will be helpful in understanding other competencies in this module.

II. To develop the ability to identify the various types of pests in your area and the damage done by each

Teacher Preparation

Subject Matter Content

No attempt will be made at this time to list and identify the thousands of types of pests which attack our people, livestock, and crops, nor to identify them or explain the type of damage each can do. Rather, an outline will be provided into which pests of your area can be cataloged and the type of damage they

do can be fit. It is suggested that the teacher and the students collect for study purposes samples, colored slides, or pictures of both, of the common pests in your area and the damage they cause. It is realized that not all pests can be studied and that it will be impossible to collect or see all pests or examples of the damage done by them. However, before a student can be effective in a chemical sales or service occupation, he will first need to be able to identify the pest problem and secondly, recommend a realistic control program. Certainly the more pests and pest control problems with which he can be familiar, the more valuable he will be to the business in which he is employed and to the customers he serves.

Most pest that are of concern to farmers, ranchers, gardeners, orchard men, homeowners, and others, can be grouped into six major areas.

1. Weeds
2. Insects and insect-like creatures
3. Diseases
   a. Bacteria
   b. Viruses
   c. Fungi
4. Rodents
5. Nematodes
6. Mollusks--snails and slugs

To effectively control these pests chemically, it is important to know something about the characteristics of them.

Weeds

The basic characteristics of weeds that assist us in developing chemical eradication programs are:

1. Life span of the plants
2. Method of reproduction
3. Type of leaf structure

Weeds are generally classified by life span.

1. Annuals

    a. Complete life cycle in one year

    b. Reproduce only be seed

    c. Are usually broad-leaved plants (Annual blue grass is not considered a broad-leaf plant for example.)

2. Biennials

    a. Complete life cycle in two years

    b. Reproduce only by seed

    c. Are broad-leaved plants

3. Perennials

    a. Live three or more years

    b. Reproduce by seed or vegatatively

    c. Blade (grass) or broad-leaved plants

Annuals and biennials can be controlled by eliminating seed production; however, perennials can reproduce by seeds, roots, rhizomes and/or stolens, and create more difficult control problems.

Insects

Insects that are troublesome to plants can best be catalogued as follows for chemical control. Certain pests that are not true insects are considered here as such because their damage and control are similar to that of insects. Examples of these are lice, mites, spiders and ants. When used in this module the term insect includes all insect-like pests.

1. Chewing insects, surface, or boring which attack the root, foliage, flower seed, or fruit.

2. Sucking insects which attack the foliage, flower, seed, or fruit.

3. Seed insects may be insects that attack the seed in the soil at planting, on the maturing plant, and in storage.

4. Animal insects and insect-like creatures that are common problems can be classified as:

   a. Internal parasites including worms, flukes, and cattle grubs.

   b. External parasites including flies, maggots, mosquitos, ticks, mites, and lice.

5. Another large group of insects, or insect-like creatures, are those that affect man or his personal belongings. These include:

   a. Annoyance insects such as cockroachs and ants

   b. Health hazard and disease transmitting insects such as flies, mosquitos and fleas

   c. Property damage insects such as moths or termites

Diseases

Diseases of plants and animals can be classified as bacteria, viruses, and fungi. All these types are serious pests to modern-day agriculture.

1. Bacterial diseases of plants attack most types of field and horticultural plants. These one-celled microscopic organisms are a low form of plant life and have three forms: coccus, round; spirillum, spiral; bacillus, rod-like. They gain entrance to plants through wounds and natural openings. Bacterial infections may attack all parts of a plant and the types of damage can be classified as follows:

   a. Galls - abnormal growths on a plant part

   b. Wilts - normally congest the vascular system and affect the entire plant

   c. Cankers - tissue destruction, causing leaf or tissue lesions

d. Rots - fleshy part of plants, (stems, fruit, etc.) become soft and slimy

e. Abnormal growth including dwarfing, deformed parts, and color changes.

2. Diseases of livestock are caused by bacteria and can be classified as follows:

a. Respiratory

b. Digestive

c. Circulatory

d. Reproductive

e. Tissue and bone

3. Virus diseases are also common to plants and animals. They are frequently transmitted by insects and can attack nearly all parts of plants and organs of animals. In plants, "yellows" and wilts are common problems. Little will be said about this group of diseases since chemicals available to control or treat them are limited. Chemicals can be used to control the insects that cause and spread the disease.

4. Fungi, which are a low form of plant life, cause many plant diseases. Most fungi develop threadlike structures inside and/or on the surface of the plant which interfere with proper plant growth and development. The various fungi may attack several crops or only specific plants; they may attack specific plant tissue or various plant parts. Fungi can be classified as follows:

a. Scabs

b. Rots

c. Rusts

d. Smuts

e. Molds

f. Powdery mildews

g. Blights

h. Leaf spots

Fungi can cause certain disorders with livestock but they are not as prevalent as in plants. The only common diseases are skin or tissue and respiratory diseases.

Rodents

Rodents are another common pest that can be effectively controlled with agricultural chemicals. They are frequently problems in connection with:

1. Crop storage
2. Horticultural crop production
3. Human food storage
4. Health hazards to humans
5. Building destruction
6. Human annoyance

Nematodes

An increasingly serious pest in many areas of the United States is the nematode. These are small roundworms which live in the soil and frequently enter the plants through the roots. They live on the plant juices and affect plants as follows:

1. Produce galls or knots on roots
2. Stunt or deform plant growth
3. Cause injury which permits disease to attack plants.

Nematodes are not an insect and while they do cause insect-like damage they are not controlled effectively by insecticides.

Mollusks

Mollusks are the snails and slugs that are an unwelcome sight to gardeners. They do their greatest damage by eating foliage and fruit.

Damage by Pests

The pests discussed are considered undesirable for one or more of the following reasons. They:

1. Reduce yields of crops or livestock
2. Compete for food, water, space, and sunlight

3. Destroy property such as feed, clothing, and buildings.

4. Cause or transmit disease

5. Cause poisonous or toxic conditions

6. Are an annoyance to man or animal

7. Lower the quality of desired products

Suggested Teaching-Learning Activities

1. Collect specimens of local weeds, insects, diseases, rodents, nematodes, and mollusks that are of economic importance to your community. Where specimens are unavailable collect colored pictures. The students should learn to identify as many of these pests as possible. (A hand lens is helpful for identifying insects and a microscope for identifying bacteria.)

2. Distinguish between viruses and bacteria by showing bacteria under a microscope. Explain that viruses cannot be seen under an ordinary microscope, but must be isolated by means of a porcelain filter. (Visit a laboratory or show a film so the class will understand the filtering of viruses.)

3. Collect specimens of damage caused by the various pests. Learn to identify these. The students should be able to identify plant specimens as to whether the damage is caused by disease, insect, etc., and further determine if the insect damage is caused by chewing or sucking.

4. Develop a table with the student categorizing the damages, costs, and affects of different pests.

Suggested Instructional Materials and References

Instructional materials

1. Specimens of pests and pest damage

2. Colored slides and/or charts and pictures of pests and pest damage. Most agricultural chemical companies have colored charts available.

References

1. Agriculture in Our Lives, pp. 361-362, 509-516, 535-548, 571-579.

2. U. S. D. A. Yearbooks.

Suggested Occupational Experience

Students at their training center should gain experience in helping customers identify their pest problems.

III. To understand the responsibility involved in recommending the correct pesticide

Teacher Preparation

Subject Matter Content

Once the student can correctly identify the pest problem he can intelligently consider the control procedure. However, before recommending a pesticide, two questions must be considered.

1. Is the problem severe enought to merit the cost of treatment?

2. Is chemical control the best treatment?

If the answer to both questions is yes, then it is time to determine the best pesticide to use. Factors to consider here are:

1. Cost of the various pesticides suitable for treating this problem

2. Safety of the various pesticides as to:

   a. Residue left on product

   b. Persons handling insecticides

   c. Side effects on crops, livestock, birds, beneficial insects, etc.

It is only desirable to use pesticides when it is clear that the benefits outweigh the disadvantages and when pesticides are a better way of handling the problem than are alternative methods.

Pesticides can be divided into major categories much like the pests themselves.

1. Herbicides - weeds
2. Insecticides and miticides - insects
3. Bactericides and fungicides - diseases (There are no effective chemicals for the control of viruses.)
4. Rodenticides - rodents
5. Nematocides - nematodes
6. Molluscicides - mollusks

Herbicides

Three types of herbicides depending on their effects on plants exist:

1. Contact materials
   a. Part of the plant covered by the chemical is killed.
   b. Little or no movement of chemical in the plant takes place.
   c. Effective on annuals and will not kill roots of biennials or perennials
   d. Examples - dinitro butylphenol and penta chloro phenol
2. Growth regulators (systemic herbicides)
   a. Absorbed by foliage or roots
   b. Translocated to all plant parts
   c. Chronic - kills slowly
   d. Overdose on leaves may kill cells and prevent translocation
   e. Effective against annual, biennials and perennials
   f. Examples - 2, 4-D and atrazine

3. Soil sterilants

    a. Prevent growth of all green plants

    b. Varying residual toxicity

Herbicides may be selective or non-selective. A selective herbicide will only be toxic to specific plant species while a non-selective herbicide will be toxic to all plant species. The ideal herbicide is one that is nearly non-selective, that is, it controls all plants except the desired plant species.

Selective herbicides react differently on various plant species. They may work independently or in combination with others to control weeds selectively.

1. Amount of chemical applied

2. Time of application

3. Method of application

4. Chemical and physical properties of the herbicides

5. Genetical or physical properties of the plant

Insecticides

Insect control can be achieved by several methods of which chemical control is one. To control insects with the use of chemicals, it is necessary to:

1. Use the correct chemical

2. Apply it at the correct time

3. Apply it in the right way

There are four types of insecticides which kill or control insects. They are:

1. Stomach poisons

2. Contact poisons

3. Repellants

4. Attractants

Stomach poisons must enter the digestive tract of the insect before they are effective. For insects with chewing mouth parts, applying the poison to the surface on which the insect feeds is adequate. Before stomach poisons can work on insects having sucking or syphoning mouth parts, systemic poisons are needed. These are chemicals that become part of the plant or animal tissues from which the insect extracts the juices on which it lives.

Contact poisons are chemicals that can enter the insect by means other than the digestive tract. They may enter through surface tissues or the respiratory tract. These chemicals are most frequently used against insects with sucking mouth parts: however, they are generally as effective on insects with chewing mouth parts. Fumigates normally act as contact poisons.

Chemical insect repellants actually do not kill most insects although they may injure certain types. They are used to keep insects away from places where they will do harm or cause annoyance.

An insect attractant, or lure, is a material whose vapor, when reaching the insect, draws the insect to it. There are basically three types of attractants; sex, food, and oviposition lures. These lures may be of synthetic or natural origin. Sex lures seem to be the most effective but considerably more research will be needed before this method of controlling insects becomes of widespread value.

There are many chemical insecticides available. Some are for general application and others for specific uses.

1. Arsenicals
   a. Stomach poison
   b. Newer chemicals are reducing their importance.
   c. Examples - lead arsenate, paris green, white arsenic
2. Fluorine Compounds
   a. Stomach poison
   b. Commonly used to control animal insects
   c. Examples - sodium fluoride, cayolite

3. Clorinated Hydrocarbons

   a. Large groups of synthecized insecticides

   b. Stomach poisons, some contact toxicity

   c. Hazardous to use

   d. Examples - aldrin, dieldrin, chordane, lindane toxaphene, methoxychlor, DDT

4. Phosphates

   a. Generally more hazardous to use

   b. Contact or stomach poison

   c. Examples - parathion, malathion, systox, diazinon, phosdrin

5. Nicotine compounds

   a. One of the older insecticidal materials

   b. Deadly stomach poison

   c. Examples - nicotine sulfate (Black Leaf 40), nicotine bentonite

6. Oil sprays

   a. Used alone or as carriers of other insecticides

   b. Contact poison

   c. Petroleum oils are the source of such sprays.

7. Mercury compounds

   a. Extremely toxic

   b. Stomach poison and repellant

   c. Examples - calomel, corrosive sublimate

8. Pyrethrum

   a. One of the oldest and safest materials

   b. Botanical insecticide, derived from genus chrysanthemum

c. Contact poison

d. Examples - pyrethrum, allethrin

9. Rotenone

a. Botanical insecticide, derived from the derris or timbo plant

b. Contact poison

c. Toxic to animals, very toxic to fish

10. Phenothiazine and piperezine to control internal parasites of livestock

Disease Control

Disease pests are controlled with bactericides and fungicides. There are no effective chemicals on the market for the control of plant viruses; however, certain viruses are transmitted by insects; therefore, use of insecticides that control insects indirectly controls viral diseases. Fumigation of seed beds has reduced viral diseases in some plants, but it is questioned whether fumigation kills the virus organisms, or kills the insects that transmit the virus. Sulfa drugs and antibiotics will control certain viruses in livestock

Bactericide

Bactericides are rather common for control of bacterial diseases in animals. They can be classified as follows:

1. Antibiotics

2. Sulfa Drugs

3. Furazolidone

There is more limited use of bactericides in controlling bacterial infection in plants. Generally the treatments have been of limited success and costly. The antibiotic streptomycin has provides some control of:

1. Fireblight in apples and pears

2. Walnut blight

3. Prevention of blight, knots, galls and rot of certain plants

Fungicides

Fungicides are used to control fungus diseases in animals and plants. Few fungi bother animals. The following are three that do, however.

1. Foot Rot - controlled by copper sulfate
2. Lumpy jaw - controlled by potassium permanganate
3. Ringworm - controlled by tincture of iodine

Plants of nearly all species are attacked by fungi. Seeds, roots, stems, leaves, flowers and fruit parts are all susceptible to fungi infection. Considerable progress has been made to control these diseases by the development of resistant varieties and improved cultural practices. Still, the only practical means of controlling fungi on many plant species is by a sound fungicide program. As with other pesticides, the chemical to use and time and method of application are critical for most fungi diseases. Frequently several applications of fungicides must be applied.

There are five basic types of fungicides.

1. Sulfure and sulfur compounds
    a. Lime-sulfur is common
    b. Tend to be caustic to plants when
        1) heavy applications are used
        2) humidity is high
        3) temperature is high
    c. Material should be finely ground
2. Copper compounds
    a. Bordeaux mixture - one of the early fungicides
    b. Other copper compounds

3. Formaldehyde

   a. Highly poisonous and irritating

   b. Formerly used to treat seed, fumigate storage buildings and soil, now largely replaced by newer chemicals

4. Mercurial Compounds

   a. Used for seed treatment

   b. Quite poisonous

5. Organic Compounds

   a. More effective than older materials

   b. Most important group of present day fungicides

   c. Divides into seven major groups of organic fungicides

   d. Examples - ferbam, nabam, thiram, captan, gylodin, bioguin, choronil

Rodenticides

Rodenticides are those chemicals used to control rats, mice, and other rodent and small animal pests. Rodent damage can be controlled by destroying the rodents or by using a repellant to keep them away. Some of the more important rodenticides are:

1. Warfarin

   a. Anticoagulant - causing death by internal hemorrhaging

   b. Slow acting - kills with small doses

   c. Readily accepted by rodents - mixed with grain

   d. Non-poisonous to large animals and pets which can vomit.

2. White Arsenic

   a. Rodents detect taste and become bait shy

   b. Very poisonous to all animals

3. Zinc Phosphide

   a. Used to control rats, mice, ground squirrels, and prairie dogs

   b. Offensive odor to humans

4. Strychnine

   Chiefly used to control squirrels, gophers, and rabbits (very poisonous and not sold at farm supply centers)

5. Sodium Fluoroacetate

   a. Used only by licensed pest control operators

   b. Fast acting, affects heart and nervous system

   c. Used on rodents and warm blooded pests such as the coyote

6. Pivalyl

   a. Tasteless, odorless - rodents do not become bait shy

   b. Mixed with grain

7. Diphacinone

   Anticoagulant rodenticide

8. Calcium cyanide

   a. Fumigant - used to control rodents in seed houses, elevators, etc.

   b. Toxic gas to humans

9. Thallium salts

   a. No taste or smell

   b. Used with grain

   c. Used for rodents, ground squirrels, and prairie dogs

This is a partial list of the materials used to control rodents and other warm blooded pests. The anticoagulant materials are most commonly used. Most rodenticides are toxic to all warm blooded animals and therefore care must be taken to protect domestic animals and humans from them.

Nematocides

Nematocides are used to control nematodes. These small animals are a type of round worm that generally live in the soil and cause damage to seeds, seedlings, roots and occasionally to above-ground parts of plants such as mums. Control is generally accomplished by fumigation. Four basic materials are used:

1. Methyl biomide
2. Chloropicrin
3. Dichloropropene
4. Ethylene dibromide

These materials are effective in controlling other pests at the same time they are controlling nematodes. Soil temperature should be above 55° F. and the soil should have good tilth when fumigating.

Molluscicides

Molluscicides are used to control snails and slugs. The only material generally recommended is metaldehyde. Calcium arsenate is mixed with it particularly if metaldehyde is used under humid cloudy conditions.

Mixing Pesticides

Frequently pesticides are mixed together to make composite materials. Two insecticides may be part of one "trade name" product or possibly an insecticide and fungicide are combined. Many of these combinations are available containing two or more pesticides. Before attempting to mix various pesticides together, it is necessary to check their compatibility. Refer to compatibility tables brough up to date each year by State Extension Services or available from major chemical firms.

Non-Pesticides

There are some agricultural chemicals used that are not pesticides. Two of these are:

1. Desiccants and defoliants that speed up the drying of plant tissue for easier harvesting of certain crops. An example is the use of endothal, magnesium chlorate, or calcium cyanamide as a defoliant of cotton.

2. Hormones or growth regulants. Examples of these are:

   a. Cycocel used on poisettas to shorten the plant and give brighter color

   b. Dinitro compounds used to thin blossoms on fruit trees

   c. Gibberellin used to induce elongation of internodes and create other effects on both ornamentals and vegetables

   d. Moleic hydrozide which retards sucker growth on tobacco plants

   e. Naphthaten acetic acid which inhibits preharvest apple and pear drop

   f. Naphthyl acetomide which is used to induce plant cuttings to root

Materials Mixed with Pesticides

Pesticides frequently have various ingredients added to or mixed with them which make them more effectve and/or easier to handle or use. Several of the more important types of materials are:

1. Carriers, Diluent or Extendors. This may be any liquid or solid material added to a pesticide to facilitate its preparation, storage, shipment, or use. Some of these materials are:

   a. Allapulgite

   b. Calcium carbonate

   c. Talc

   d. Koolinite

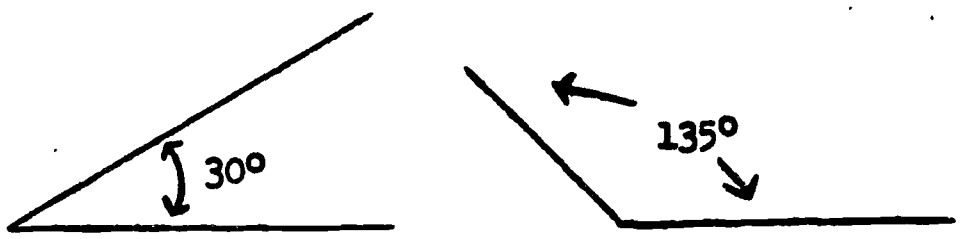
e. Vermiculate used for granular pesticides

f. Corn cobs used for granular pesticides

2. Surfactants, surface active agents or adjuvants

a. Wetting agents

These compounds increase a liquid's ability to moisten a solid. You have seen droplets of water "stand" on a plant leaf and not "spread" out. Wetting agents cause them to spread and may increase effectiveness of the pesticide. Examples of wetting agents are detergents, clays, long chain alcohols, and others.



With wetting agent No wetting agent

b. Emulsifying agents

1) materials that facilitate the suspension of one liquid in another
2) are needed when mixing oil base pesticides in water
3) several hundred types available

c. Dispensing agents

1) materials that reduce the cohesive attraction between like particles
2) assist in keeping powdered pesticides in suspension and reduce nozzle blockage

d. Adhesive agents

1) materials that increase the retention of the pesticide on the surface to which they were applied
2) similar to wetting agents
3) casein, oils gums, and resins are examples of materials used

3. Activators and deactivators

   a. Activators are materials that increase the effectiveness of the pesticide by chemical, physical, or mechanical means.

   b. Deactivators are materials that decrease the effectiveness and should be avoided.

4. Safeners are materials added to certain pesticides to reduce the danger and act as buffering agents in forming less harmful chemical combinations by:

   a. Adding lime or zinc sulfate to arsenicals

   b. Adding sulfur to toxophene

Suggested Teaching-Learning Activities

1. Have the students collect labels of common pesticides used in your community. It is recommended that full or empty pesticide containers not be collected due to the toxic conditions of many of the materials.

   a. Determine the type of each pesticide, fungicide, herbicide, etc.

   b. Determine the active ingredient of each pesticide.

   c. Determine the specific use of uses of each pesticide.

2. With a "spell-down" type of approach have the students answer these types of questions.

   a. What product would you use to control annual weeds in corn?

   b. When would you use organic phosphate chemical?

   c. What type of pest would lead arsenate control?

   d. Cattle grubs can be controlled by the use of what specific pesticide?

   e. What fumigate is good for controlling nematodes?

3. Compare the costs of various chemicals designed to accomplish the same purpose. Prepare a table showing the cost per acre against the loss expected from the insect or disease.

4. Conduct a demonstration to show the effect of contact, systemic and soil sterilant herbicides on annual and perennial weeds.

5. Demonstrate the translocation of systemic herbicides by treating susceptible perennial plants in various ways, such as leaf sprays, soil treatment, etc.

6. View healthy plant stem tissue and plant stem tissue that has been affected by a systemic herbicide.

7. Arrange a field trip to some commerical fruit or vegetable farm and have the manager explain the use of pesticides in his operation.

8. If possible collect numbers of several common insects and demonstrate the effectiveness of stomach and contact insecticides on each.

9. Obtain some soil containing harmful soil organisms. Fill two flats, fumigate one, and plant both flats with a highly susceptible plant, such as tobacco, and observe the results.

10. Have a veterinarian speak to the class about the common pests of local livestock and the pesticides used to control each.

11. Demonstrate the use of hormones or growth regulants on plants. Cycocel, gibberellin, and naphtyl acetomide could be used for effective laboratory demonstrations.

12. Demonstrate how a wetting agent will improve the spreading a spray on waxy leaves.

13. Use role playing. Use one student as clerk-sales person recommending and selling pesticides to another student as a customer.

Suggested Instructional Materials and References

Instructional materials

1. Labels obtained of all common pesticides used in your community.

2. Necessary soil, seeds, plants, cuttings, pesticides, and containers collected to conduct the demonstrations that will assist the students in understanding the use of the various pesticides.

References

1. Pesticide Handbook - Entoma. pp. 19-21, 55-302.
2. Farm Chemical Handbook, Section on Dictionary of Farm Chemicals.
3. Weed Control: As a Science, pp. 21-23, 52-63, 81-91.
4. Agriculture in Our Lives, pp. 527-531, 557-561, 583-593.
5. The best and most up-to-date references will be your state bulletins on pests and pesticides.

Suggested Occupational Experiences

1. Have the student become familiar with all the pesticides handled by his training center including their location in the store, size of containers, price, and use of each.
2. Give student experience in recommending and selling pesticides to customers.

IV. To develop an understanding of the difficulty involved in recommending correct practices to follow in the application of pesticides

Teacher Preparation

Subject Matter Content

Once the specific pest for which treatment is desired is identified and the correct chemical is determined for it's control, consideration must be given to applying the pesticide. There are four basic factors to consider:

1. The form of physical properties of the pesticide
2. The time to apply the pesticide
3. The method of applying the pesticide
4. The amount of pesticide to apply

Pesticides are available in three basic physical forms - solid, liquid, and gas. Each is for various purposes, requires different application methods, and has specific advantages and disadvantages

Pesticides in Solid Forms

There are different forms of pesticides available as solids.

1. Dust, the common type of solid pesticide, has the following characteristics:
   a. Lighter than liquids
   b. Less work in preparation for application
   c. Difficulty in obtaining even application
   d. May lose effectiveness faster than sprays
   e. Certain pesticides cannot be manufactured as dusts; oils are an example
   f. Danger of dust and vapor drift
   g. Examples of the use of dust are:
      1) seed treatment to control fungus
      2) seed flats to control damping off
      3) vegetables and fruit dusted by airplane
      4) power dusters mounted on tractors to dust fruit trees
      5) hand dusters for home gardeners, some with CO_2 rechangeable
      6) dusting livestock for mites, lice, grubs, etc.
      7) aerosol bombs for moth proofing
2. Granules - a solid type pesticide
   a. Small, free flowing particles
   b. Often mixed or combined with a carrier to provide enough bulk for even distribution
   c. Applied by hand or mechanical spreaders
   d. Applied as granules, no water needed
   e. Fall or roll off leaves, preventing plant injury

f. Difficult to apply as uniformly as sprays

g. Examples of the use of granules are:

1) insecticides used to control soil root worms
2) systemic herbicides applied to soils
3) insecticides that catch in corn whorls for corn borer control

3. Baits - grain mixtures, pellets, cubes, etc.

a. Various solid forms - not dusts or granules

b. Placed by hand where pests are located

c. May be used with bait boxes

d. Act as stomach poisons

Pesticides on Liquid Form

Liquid materials are the most common form of pesticides. These materials are available in the following forms:

1. Wettable powders

a. Sold as powders or dusts

b. Mixed with water for application

c. Powders do not dissolve, stay in suspension. (Demonstrate with quart glass jar of water.)

d. Agitation required with some to maintain suspension

e. Improper suspension can cause

1) nozzle clogging
2) uneven application

f. Wetting agents assist in maintaining suspension

g. Many pesticides are available as wettable powders.

2. Emulsions

a. Oil base or oil-like pesticides

b. Mixed with water for application

c. One liquid mixed in another, each maintains its own identity

d. May require agitation to prevent separation

e. Mixture generally has a "milky" color

f. Emulsifying agents facilitate suspension

3. Salts

a. Sold as dry materials, dissolve in water. (Demonstrate with quart glass jar of water.)

b. Become homogeneous mixture of the water and salt

c. Spray is clear, may be colored, not cloudy

d. Salt cannot be separated from water by mechanical means

e. Uniform spray is assured

4. Solutions

a. Sold as clear liquids, may be colored

b. Become homogeneous mixture with water

c. Materials will not separate

d. Uniform spray is assured

Pesticides in the Form of Gas

Limited amounts of pesticides are sold as gases. They are used as fumigates to control nearly all types of pests. Certain solid and liquid materials also vaporize and are used as fumigates also.

Time of Application

Several factors will influence the time to apply chemical pesticides. Under certain conditions these factors will tend to conflict with each other and then judgment is needed to determine the most appropriate time for applying the materials. The inexperienced sales person cannot make this decision but must realize that he should defer to the judgment of an experienced

field man or store manager. Factors of timeliness which should be considered when making a sales presentation or conditioning the customer to seek expert advice from others within the organization are:

1. Must be based on pest prevention rather than cure

2. Must be applied before the pest can do damage

3. Level of residue remaining on or in edible products must be considered

   a. Chemical residue may be harmful to humans, animals, subsequent crops, and beneficial flora.

   b. Chemical residue must be removed or destroyed in processing.

4. Must be applied when the pest is most susceptible

5. Must be applied at a time when it will do the least damage to the plants and animals

6. Must be applied at a time when the least damage will result to beneficial organisms or to the environment

Generally, when symptoms of pest damage appear, it is too late to obtain effective control. Therefore, past experience must be the basis for determining the time to use pesticides. Examples of these are:

1. When "damping off" occurs in seed beds it is too late to fumigate.

2. When cattle show the symptoms of grubs it is too late to control the heel fly.

3. When scabs already have formed on apples, it is too late to use fumicides.

There are some times when it is possible to control the problem after signs of it appear. Examples of these are:

1. Spraying for army worms when the population begins to multiply

2. Dusting cattle with rotenone when grub symptoms appear on their backs

3. Spraying the corn field with herbicide as the annual weeds appear

It will be necessary for each instructor to develop with the students a time table of pest control for all the major pest problems in your community. Just as it was impossible to develop a list of all pests, or pest damages, it is impossible to make a listing of all pesticides to use.

Some of the more common times to apply pesticides are given.

1. Pre-plant - soil pesticide treatment
2. Pre-emergence - between planting and emergence
3. Post-emergence - after weeds and/or crops are up
4. Seed, corns, tubers, etc., before planting
5. Dormant vegetative treatments
6. Pre-bud, bud, blossom cover sprays or dusts
7. Foliage or cover sprays
8. Storage applications to control insects, disease and rodents

Method of Application

The method to use in applying pesticides will be determined by the following factors:

1. Type of material used; solid, liquid, gas
2. Location of the pest; soil, foliage, greenhouse, grain
3. Size, storage, etc. of the pest problem; one rose bush or hundreds of acres of corn
4. Type of pest; rodent, fungi, sucking or chewing insects, etc.

The method of applying pesticides must be considered also. There are situations where the correct method may conflict with a timeliness factor or with another method consideration. Factors to consider when determining a method are:

1. The method used must not result in residues that exceed the tolerances established for the pesticide.

2. The method used must not leave residues that will be harmful to following crops.

3. The method used should provide complete covereage or protection of the plant or animal from the pest.

4. The method used should be safe to the person applying the material.

5. The method should be economical.

6. The method must do minimal damage to the crop, animals, or the biological flora that are beneficial.

7. Compatibilities of various chemicals must be considered when determining methods of application.

Only a summary of the methods of applying pesticides is presented in this module. Methods of applying the common pesticides in your area should be more fully discussed.

Dust Application

Dusting of plants and animals can be from a very simple to a highly mechanized operation.

1. Simple shaker can

   a. Container with holes at one end.

   b. Quite unsatisfactory, covers only upper surface of leaves. (Demonstrate using flour or other cheap non-toxic dust.)

2. Hand duster with a bellows or plunger pump to create an air blast. (Demonstrate using flour or other non-toxic powder.)

3. Power air blast dusters mounted on tractors or trailers

4. Airplanes with dusters

Various dust pesticides may be applied:

1. To the soil

2. To seeds, bulbs, corms, tubers, etc.

3. To plant foliage

4. To livestock to control external parasites

Granular Application

Granular pesticides can be applied by:

1. Hand scattering
2. Broadcast applicators of many sizes and kinds
3. Band applicators to place the pesticide in the row or to the side of the row. Granular pesticides may be applied at the pre-emergence stage or to foliage at the post-emergence stage.

Granular applicators need to be carefully calibrated and accurately designed to uniformly apply the small amounts normally required. Insecticides and herbicides are frequently applied as granules, most frequently on or in the soil.

Liquid Application

Liquids are the most common type of pesticide and spraying is the most popular method. Water is the common diluent or carrier of the pesticide. Spraying has the advantage of more uniform, complete coverage, varying in amount from one gallon to hundreds of gallons, and keeping spray drift to a minimum.

Sprays can be applied with:

1. Sprinkler cans
2. Aerosol bombs
3. Hand pump types of sprayers, some of these use rechargeable CO_2 cylinders to eliminate hand pumping
4. Power sprayers
   a. Portable units
   b. Tractor mounted
   c. Truck or trailer mounted
   d. Airplane type

Power sprayers can be:

1. Low volume type
   a. Apply 1-30 gallons per acre
   b. Drops are large; little or no drift
2. High volume type
   a. Apply 30-500 gallons per acre
   b. Large drops to mist size drops determined by pressure and nozzle size
3. Air blast sprayers carry spray by high velocity air currents, cause a fine mist or fog, and give excellent coverage to all surfaces.

Sprayers can be used to spray soils, plants in all stages of maturity, and livestock. Spray can be directed to specific areas where needed. Examples are when drop nozzles are used to control weeds in row crops and when control of ground vegetation in orchards is desired.

Liquid pesticides can be applied in manners other than by sprayer.

1. Pour on soil to control a pest or serve as a soil fumigant.
2. Pour over grain in bins to control insects.
3. Dip or soak various plant parts and seeds in pesticides.
4. Set out liquid baits for rodents.
5. Give drenches to livestock to control internal parasites.
6. Dip livestock to control external parasites.
7. Treat seed by the slurry process.
8. Brush on heads of cattle to control face flies.

Gaseous Application

Gaseous pesticides are either forced or allowed to drift into the areas in which they are desired. If the gaseous pesticide is volitalized from a solid or liquid material it might be applied as a solid or liquid. Most gaseous pesticides are heavier than air, and will move down into soil, grain, etc. These materials are generally extremely toxic to humans and must be used with utmost caution. Enclosures must be sealed to prevent the gases from escaping and seed beds must be covered with a plastic tarpaulin.

Safety with Pesticides

If one statement could be given to remember about this competency on application of pesticides it would be, "Follow the directions accurately and don't use or apply any pesticide until you are sure you know when and how to use it." Pesticides are dangerous to handle and should only be used by qualified people.

Two rules are given to follow in regard to the amount of pesticide to apply.

1. Read the directions.

2. Apply the stated amount - no more or no less.

The amount of material used to control pests should always be the least amount necessary to control the pest effectively. This amount is frequently difficult to determine, however, due to the variations in methods of application, climate, soils, or other factors that tend to control the effectiveness of a chemical. Problems that may develop by using the incorrect amount are:

1. Ineffective control of the pests

2. Damage to the plant and animals

3. Products containing chemicals in excess of the tolerance limitations.

4. Destruction of beneficial organisms

Determining the Amount of Pesticide to Use

The amount of material to use is expressed as an active ingredient. Active ingredient is that part of the chemical formulation which

is directly responsible for the effects of the pesticides. Examples of this are:

1. A gallon of pesticide weighs ten pounds and is forty per cent active ingredient. Therefore it would have four pounds of active ingredient.

2. A pound of wettable powder contains twenty-five per cent active ingredient, therefore, four pounds of this wettable powder would contain a total of one pound active ingredient.

Two other problems in the application of pesticides are the mixing of the pesticide and the calibration of the applicator. Most labels on pesticides give directions on mixing and on the amount to apply to a certain area. How do you determine how much to prepare for a certain size area and how do you determine if you are applying the pesticide at the correct rate?

Most colleges of agriculture and many commercial companies publish bulletins or pamphlets on mixing and calibration. Students will need this type of information for reference, since it is more realistic to refer to these than to attempt to memorize the ratios and formulas needed to mix various quantities of pesticides or calibrate various dusters, sprayers, or granular applicators.

Duplicating the following tables and problems for the students and taking time to instruct them on the use of these tables in similar problems will give the students the experience necessary to use them accurately. This is especially appropriate at the post-high school level.

Rate of Application Equivalents

1 ounce per sq. ft.	=	2,722.5 lbs. per acre
1 ounce per 100 sq. ft.	=	27.2 lbs. per acre
1 pound per 100 sq. ft.	=	435.6 lbs. per acre
1 pound per 1000 sq. ft.	=	43.6 lbs. per acre
1 pound per acre	=	1/3 ounce per 1000 sq. ft.
5 gallons per acre	=	1 pint per 1000 sq. ft.
100 gallons per acre	=	1 quart per 100 sq. ft.
100 gallons per acre	=	1.85 pounds per 100 sq. ft.
3 teaspoons	=	1 tablespoon
2 tablespoons	=	1 fluid ounce
8 fluid ounces	=	1 cup
2 cups	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon
1 acre	=	43,560 sq. ft.

Pesticide Dilution Chart

To weigh small amounts of pesticides is not practical for most people, therefore, the common household measuring equipment of a cup, tablespoon, and teaspoon are suggested. All dilutions are sufficiently accurate for the small grower. There may be slight variations in weights per volume of various materials. This is a general dilution chart which gives the amounts of pesticide for 100 gallons of spray into proportionate amounts for 2½ gallons and 1 gallon lots.

For 3-gallon compressed air sprayer, make up 2½ gallon of spray.

Type of Material	Quantity of material for 100 gallons	Quantity of material for 2½ gallons	Quantity of material for 1 gallon
Wettable Powder Pesticides	1 pound	2½ tablespoons	1 tablespoon
	2 pounds	1/3 cup	2 tablespoons
	3 pounds	1/2 cup	3 tablespoons
	4 pounds	2/3 cup	4 tablespoons
Liquid Pesticides	1 pint	2 1/2 teaspoons	1 teaspoon
	1 quart	5 teaspoons	2 teaspoons
	2 quarts	3 1/2 tablespoons	4 teaspoons
	2 gallons	3/4 cup	1/3 cup

A little simple arithmetic can take the head-scratching out of figuring just the right amount of pesticide to use to obtain a specified mixture. Here's how:

Example: Wettable powder

The number of pounds of wettable powder to use in mixing any given quantity of spray or dip of a given percentage toxicant can be figured by the following formula:

$$\text{lbs. wettable powder to use} = \frac{\text{No. of gal. of spray} \times 8.345 \times \text{\% toxicant desired in spray}}{\text{percent toxicant in wettable powder}}$$

Example. 500 gallons of spray containing 0.25 percent DDT is needed. The wettable powder to be used contains 50 percent DDT.

$$\frac{500 \times 8.345 \times 0.25}{50} = 21 \text{ lbs. wettable powder}$$

Water is then added to make 500 gallons of spray.

Example: Liquid Pesticides

Use the formula below to determine the gallons of concentrate to be used in making up an emulsion of a given percentage of toxicate by weight.

$$\frac{\text{No. of gal. of spray} \times \text{\% toxicant desired in spray}}{\text{\% toxicant in concentrate}} = \text{gal. of concentrate}$$

Example. 2.5 gallons of spray containing 2 per cent chlordane by weight is to be prepared from a concentrate containing 40 per cent chlordane. The amount of concentrate that will be needed is:

$$\frac{2.5 \times 2}{40} = .125 \text{ gallons}$$

.125 gallons = 1 pint

Example: Dusts

Use the following formula to determine the weight of pesticide material to be used in preparing a dust containing a given percentage of toxicant.

$$\text{Quan. of pesticide material needed} = \frac{\text{\% of toxicant desired} \times \text{lbs. of dust to be made}}{\text{\% toxicant in insecticide mtl.}}$$

Example. 100 pounds of dust containing 0.5 per cent of rotenone is needed. The powdered root to be used contains 4% of rotenone. The quantity of powdered root needed is:

$$\frac{0.5 \times 100}{4} = 12.5 \text{ lbs.}$$

Sufficient dilutent is added to make 100 lbs.

Calibration when spraying or dusting four roses, ten hills of melons, or one apple tree is nearly impossible. The best suggestion is to follow the directions given on the label of the pesticide. With dust, the recommendations may read, dust lightly or dust with ½ teaspoon per plant at bud stage. Liquid sprays may suggest, spray thoroughly until droplets roll off leaves; spray till foliage is entirely wet; or spray lightly with fine mist. These recommendations are vague at best, but follow them as accurately as possible, using pesticides of the correct strength. Do not attempt to double the strength and apply one-half as much.

With larger areas, dust spray and granular applicators can be adjusted accurately in gallons or pounds. There are three factors that enter into the calculations when calibrating applicators.

1. Speed at which applicator moves

2. Rate of pressure or size of applicator openings

3. Width the applicator covers

Calibrating Equipment

There are several methods used to calibrate applicators. Three of these are discussed here.

1. Tables are prepared by the manufacturer of the applicator. These tables indicate that at a specific pressure and/or applicator opening, a designated number of gallons or pounds will be applied to a specific area.

2. Special measuring or metering devices are available where the applied materials are collected in containers for a prescribed time or distance and this material is measured or weighed and the rate of application is then determined from prepared tables.

3. Measurement of gallons or pounds of pesticide delivered is a procedure that can be used without special tables or equipment. Steps in this procedure are:

   a. Fill applicator to a measured mark or level.

   b. Travel a measured distance at applicating speed.

   c. Refill applicator to the measured mark or level and determine pounds or gallons used.

   d. Calculate area covered in number of square feet.

   e. Divide 43,650 square feet (acre) by square feet covered and multiply answer by gallons or pounds used. This will give the answer in gallons or pounds per acre.

   f. Adjust the rate of speed or applicator if the rate applied was wrong. It may be necessary to recalibrate the applicator.

This method may be used to calibrate for acres or for smaller plots. Following are examples using this method.

Example: Sixty gallons of herbicide are desired per acre. The applicator is filled to a predetermined level and pressure and we begin to spray at a uniform speed. Distance travelled was 20 rods, width of applicator was 20 feet, amount of material used was 9 gallons.

20 rods x 16.5 x 20 = 6,600 sq. ft.

$\frac{43,560}{6,600} = 6.6$ 6.6 x 9 gallons used = 59.4 gallons per acre

Example: It is desired to dust, with a hand duster, a strawberry bed with a fungicide. Recommendations call for five pounds per 1000 sq. ft. We walk at a slow pace for 25 feet and dust an area 4 feet wide, and fine we used one pound. Are we applying at the correct rate?

25 x 4 = 100

$\frac{1000}{100} = 10$ 10 x 1 = 10 pounds/1000 sq. ft.

The fungicide is being applied at twice the desired rate. We can correct the application by:

1. Walking twice as fast
2. Dusting an area twice as wide at the same pace
3. Using a diluent to reduce strength of fungicide by one-half.

When calibrating any applicator, the calibration should be done with:

1. The actual material to be used or a material of the same consistency or viscosity. (Water may be used for water-like spray.
2. Use as large an area for calibration as feasible to reduce the possibility of error. Calibrating a field sprayer on one tenth acre when 500 acres are to be sprayed is not realistic.

3. Do the calibration on a waste or open area, not in the strawberry bed, etc., unless the pesticide is known to be non-toxic to the material on which it is sprayed.

Calibration should be done frequently, as equipment may become worn and out of adjustment and the consistency or viscosity of pesticides may change. Some of the more common problems are:

1. Nozzle orifices may change size.

   a. Clogging may reduce orifice opening.

   b. Wear may increase orifice opening.

2. Pumps may become less efficient as they become worn.

3. Pressure gauges may give incorrect readings.

4. Dust or granule orifices may become worn, clogged, or corroded.

5. Moisture may cake dusts and granules. Applicators should always be cleaned immediately after use. Many materials may cause corrosion to the applicator, settle and/or cake in tanks, pumps and nozzles, or evaporate and form gum-like residues. Dust or granule applicators should be emptied, washed, and coated with a light oil to prevent rust. Spray applicators should be rinsed with an oil solvent to remove all oil-base sprays and then rinsed with a wetting agent to remove the solvent. If only solutions or wettable powders were used, a thorough rinsing with water is all that is required.

Concluding Statement

Every pest problem requires its own specific cure determined by many factors. Some of these are:

1. Climatic and soil conditions. (Some herbicides are effective on heavier soils but not on sandy soils.)

2. Use of the crop or livestock

3. Crop rotation of the field

4. Value of the crop

5. Maturity of the crop or livestock

6. Concentration of the crop or livestock in the area

7. Severity of the pest and the damage

Suggested Teaching-Learning Activities

1. Collect samples or have the students collect samples of the various forms of pesticides, dusts, granules, baits, wettable powders, salts, oils, solutions, and gases, etc. Suggest that less toxic materials be collected and that they be kept in safe storage.

2. Demonstrate in small amounts the mixing of various pesticides to show emulsions, solutions, and dissolving of salts. Point out the cloudy or milky emulsions and clear solutions. Demonstrate the effectiveness of wetting agents and emulsifiers.

3. Demonstrate the need for timeliness with the use of herbicides on weed control. Treat an area of weeds with the same material at the same rate at emergence, at rapid growth stage, and at full bloom, and note the variation in effectiveness.

4. With field trips, laboratory, or field demonstrations, acquaint the students with common pesticide applicators used in your area.

5. Develop several problems with common pesticide products used in your area to give the students experience in calculating active ingredients and amount to apply per acre.

6. Develop several problems in mixing various pesticides in your area. The problems should involve mixing small amounts, enough for a garden, and commercial amounts at varying concentration levels.

7. Have the students gain experience in calibrating common dust, granule, and spray applicators. Demonstrate how speed, pressure, and orifice or opening can change the rate of application.

8. Give the students the opportunity to properly clean dust, granular, and spray applicators.

9. Arrange a field trip(s) where students can observe a commercial operation in application of pesticides.

10. Arrange a field trip(s) to a dealer that sells and services several types and sizes of applicators.

Suggested Instructional Materials and References

Instructional materials

1. Samples of the various forms of pesticides plus diluents, emulsifiers, and wetting agents

2. Samples of the various forms of applicators or pictures or colored slides of the larger applicators used in your area

3. Copies of available bulletins, pamphlets, charts, tables, and devices used in your area to assist in mixing pesticides and calibrating applicators

References

1. Fruit Growing, pp. 123-126, 135-144.

2. Ground Maintenance Handbook, pp. 159-166.

3. Horticultural Science, pp. 255-259.

4. Weed Control: As a Science, pp. 104-121.

Suggested Occupational Experiences

1. Have the students become familiar with all the forms of pesticides handled by his training center and how each is to be applied.

2. Under the close supervision of the store manager, the student should be expected to give customers advice on how to apply the pesticides he sells properly.

3. The should be expected to give customers advice on the mixing of the pesticides and on how to calibrate the applicators which the customer will be using.

V. To develop the ability to advise customers in the safe handling, storage and use of agricultural chemicals

Teacher Preparation

Subject Matter Content

Before a student can be expected to advise customers about safety regulations in regard to chemicals, the student must know the safety regulations himself. Showing the filmstrip "Facts About Pesticides" or the film "Safe Use of Pesticides" cited in the references at the end of this competency would be a good method of introducing this competency.

Federal and state legislation has been enacted covering pesticides to protect persons from the dangers of improper use of these materials. However, the final decision as to whether the materials will be used correctly and with the proper care rests with the user of the materials.

Students should be familiar with the statutes covering the use of pesticides. These statutes are of two general groups:

1. Covering the interstate and intrastate marketing of pesticides

   a. All insecticides, fungicides, herbicides, rodenticides, plant regulators, defolients, and desiccants must be registered with the U. S. Department of Agriculture, to be marketed in interstate commerce.

   b. The manufacturer must prove that the material is not a public health hazard when used in accord with good agricultural practices.

   c. Signal words (DANGER, CAUTION, WARNING, etc.) must appear on labels of all poisonous pesticides. (Correlate with the lethal dose at the level at which 50% of test animals will die commonly called LD 50.)

   d. The words "Keep out of reach of children" must appear on labels of all poisonous pesticides.

   e. Most states have adopted a "Uniform State Pesticide Act" to control pesticides used within the state.

2. Statutes covering use of pesticides

   a. The Miller Amendment (1954) provides that any raw agricultural commodity may be condemned if it contains any pesticide that is not approved or if it contains more pesticide than the tolerance permits.

   b. The Delaney Clause stipulates that no material capable of causing cancer under any condition may ever be permitted in any food.

Agricultural chemicals are classified into eight groups according to their use and the amount of tolerance permitted. Tolerance refers to the amount of pesticide that a food product may contain and still be considered safe for use. Tolerance is expressed in parts per million (ppm) of the pesticide in or on the food product. These tolerances vary from zero or no tolerance to specified limits. An example of how tolerances may vary can be illustrated with DDT, a common insecticide.

Milk and milk by-products - zero tolerance in 1965.
Potatoes - tolerance of 1 ppm
Apples - tolerance of 7 ppm
Peppermint Oil - tolerance of 100 ppm

When pesticides are used at the rate, in the method, and at the time recommended, the harvested product should be free of any residue that would exceed the tolerance levels. Probably the best advice that can be given on the use of pesticides is to read the label and then follow the precautions.

Safety Rules

Following is a summary listing of safety precautions in the use of pesticides as they might affect crops, livestock, and food products.

1. Before using any pesticide, read the precautions.

2. Use pesticides only when necessary.

3. Use pesticides only at recommended dosages.

4. Time the use of pesticides to keep residues within the limits set by law.

5. Avoid spray and dust drift to other crops.

6. Prevent livestock from consuming feed that might result in toxic affects to them or result in residue of the pesticide in animal products.

7. Cover food and water containers in livestock areas.

8. Do not contaminate streams, ponds, or other water sources.

Safety precautions for the storage of pesticides can be summarized as follows.

1. Always store pesticides in their original containers.

2. Store pesticides out of reach of children, preferably in locked cabinets or store rooms.

3. Store pesticides where pets and livestock cannot reach them.

4. Store pesticides away from food, feed, fertilizer, and seed.

5. Store in well-ventilated, cool, dry, well-lighted room.

6. Store glass containers near floor so they will not fall and break.

7. Certain pesticides must not be stored with or near other pesticides. Read the label about warnings.

8. Certain pesticides are explosive. Do not store them near electrical wiring or other areas where fire is a potential hazard.

9. Some pesticides are destroyed by low temperatures. Again read the labels.

10. Destroy all empty pesticide containers.

    a. Break or puncture all glass and metal containers.

    b. Burn all paper or cardboard containers and avoid contact with the smoke.

    c. Bury all ashes, unburned residue, and broken containers.

11. Discard containers without labels. Do not guess at contents. Advise customers to follow this practice.

Safe Handling

The greatest danger with pesticides is to the person who handles and applies them. Many pesticides are toxic and extreme caution must be used when working with them. Some of the more common methods in which persons can be poisoned or otherwise harmed by pesticides are as follows.

1. Inhaling pesticide spray, dust, or vapors of pesticides

2. Swallowing pesticides that may be on food or in drink, by handling food with contaminated hands, or by using contaminated containers, etc.

3. Certain pesticides can cause skin irritation or actually move through the skin and enter the body causing poisoning. This is how contact insecticides work.

Precautions to prevent this type accident are:

1. Wear protective masks and clothing if so directed by the label. Rubber gloves and boots, goggles, respirator or even a gas mask with highly toxic materials, such as the hydrocarbons and the organic phosphates.

2. Never eat or smoke while spraying, dusting, or doing other work with pesticides.

3. Avoid spilling pesticides on skin or clothing.

4. Bath or shower and change to clean clothing after working with pesticides.

5. Wash clothing after each day's use.

6. Keep all other persons away during spraying and dusting operations and out of the treated area for a safe period of time after application.

7. Mix pesticides only where there is adequate ventilation.

Accident Procedure

Despite all warnings and precautions between one and two hundred persons are accidentally poisoned each year. Incidentally, there are about the same number of persons poisoned annually from overdoses of aspirin. These poisonings usually are of two types. The majority include those that consume the material accidentally,

such as children getting into improperly stored materials. The other group are those that handle and apply these chemicals in their daily work.

Persons dealing with chemicals should be well informed on what to do in case of accidental poisoning. Call a doctor immediately or rush affected person to a hospital. If this is impossible, follow first aid treatment.

1. If the poison has been swallowed

   a. Induce vomiting unless the patient is unconscious

      1) put finger or tongue depressor down the patient's throat
      2) give a common emetic such as a strong soap, salt, mustard, or syrup of ipecac solution in warm water

   b. After the stomach is emptied, give the patient raw eggs, milk, or thin flour paste to absorb poison and sooth irritated membranes. Never give the patient oil.

   c. Have the patient lay down and keep him comfortable. If patient is cold, cover with blankets. If patient is warm, cool with cold compresses.

   d. Make every attempt to get medical attention and take the container of the poison consumed to the doctor.

2. If the poison has been inhaled:

   a. Move patient to the open air

   b. Give mouth to mouth artificial respiration if the patient is not breathing

   c. Get medical attention immediately

3. If the poison has been spilled on the skin:

   a. Remove clothing and scrub skin thoroughly with plenty of warm water and soap

   b. Get medical attention

4. If the poison has gotten into the eyes:

   a. Wash out the eyes for at least fifteen minutes

   b. Get medical attention

Always be prepared to give the doctor the name of the pesticide, the strength of the material, and the approximate amount of the material the patient has consumed or to which he has been exposed. Most chemical companines have safety charts available that list the precautions and actions to take should an accident occur. These should be available wherever pesticides are stored, handled, or used. The warnings or precautions printed on the label of toxic materials should be read and understood before working with any materials.

There is a nation-wide network of poison control centers that have staff members specially trained in the treatment of poison cases. Persons working with pesticides should be aware of the location, telephone number, and person in charge of the nearest center to eliminate any unnecessary delay or misunderstandings should rapid treatment be required. Information about these centers is available for most hospitals or medical centers.

Showing the filmstrip "Points about Pesticides" cited in the references at the end of this competency would be a good way of summarizing the material in this competency.

Suggested Teaching-Learning Activities

1. Show the filmstrips "Facts about Pesticides" and "Points about Pesticides" available from the Manufacturing Chemist's Association, Inc.

2. Have the students review the available pesticide labels for the:

   a. Warnings, cautions, and dangers they include

   b. First aid instructions in case of poisoning

   c. Determine if there are tolerances established for the pesticide.

3. Arrange a visit to a wholesale or retail pesticide warehousing area. Observe what safety precautions are being observed and if any hazards to safety are evident.

4. Have the students memorize the steps in first aid treatment (pages 50-52) and grade them on oral or written presentation before they are approved for supervised occupational experience training.

5. Develop a chart showing the relative toxicity of organic phosphates, carbonates, chlorinated hydrocarbons, etc.

Suggested Instructional Materials and References

Instructional materials

1. Labels of pesticides for review

2. Post the Safety Chart from the Meister Publishing Company, 37841 Euclid Avenue, Willoughby, Ohio. No charge.

3. Filmstrips - "Points about Pesticides" and "Facts about Pesticides" available from the Manufacturing Chemists' Association, Inc. 1825 Connecticut Avenue, N.W., Washington D. C.

4. Film, "Safe Use of Pesticides," color, 1963, 16 mm, 21 minutes, U. S. D. A. Order from your state film library.

References

1. Clinical Handbook on Economic Poisons.

2. Pesticide Handbook - Entoma. pp. 3-17.

3. Commercial publications available locally.

Suggested Occupational Experience

1. The students should gain experience, under the supervision of an informed individual, on the safe storage, handling, and use of pesticide materials.

2. The students should advise customers on the safe use of the products which they are selling.

VI. To develop the ability to understand information on pesticide labels and other literature pertaining to pesticides

Teacher Preparation

Subject Matter Content

The sources of information about the correct material to use for a specific pest and how to use the pesticide are:

1. The labels on the pesticide containers
2. Catalogs, charts, tables and other materials prepared by the manufacturers of the chemicals
3. Pamphlets and bulletins that are prepared annually by most colleges of agriculture

The label on the container of pesticide is generally the best source of information. Regulations require that the label contain:

1. Name and address of manufacturer or distributor
2. Net contents in weight and/or measurement
3. Technical name or common name of the ingredients
4. Per cent by weight of the active and inert ingredients
5. Directions on use of the material including
   a. Crops or livestock on which it may be used
   b. Recommended dosage - rate of application
   c. Recommended method of application
   d. Instructions on when and when not to use the material, such as "Do not apply within 10 days of harvest."
6. Signal words (Danger, Caution, Warning, Etc.) if the material is poisonous
7. Instructions on treatment should a person swallow, inhale, or get the material on his person

Students should become aware of the catalogs, charts, tables, and other materials provided for sales persons and be instructed on how to use these. It will be necessary to accumulate as much of this type of material as possible to teach this effectively.

The students should become aware of the kinds of information these catalogs contain and how to find the information they desire. Most of the catalogs contain indexes that cross-reference the plants or animals infected with the pest involved and the materials available to control or treat the problem.

By using the index, find the crop or livestock that is in question or the specific pest problem if it is known. Once this is located in the index, the index will refer you to a page or a section in the catalog that will contain information on materials that are available for control or treatment of the pest. Frequently the catalog will have labels, sample labels, or pages that contain the same information that would be found on the original container labels. Often these same catalogs will contain information on price of products, calibration, and other questions related to the sale and use of the materials. Considerable class time should be spent in teaching how to use these catalogues and the index, not in learning the technical content the catalog contains.

Chemical companies also provide charts that assist in identifying pests and pest problems. An example of their use would be when a customer comes to the store and wants a spray to control the weeds in his lawn. By referring to the chart you might be able to identify the weed or weed problem he has, and therefore be better able to recommend the correct herbicide.

Nearly every state publishes bulletins annually that list and identify the major pest problems within the state along with the recommended pesticides and methods to most effectively control these pests. Every student should become well acquainted with the use of these bulletins.

Suggested Teaching-Learning Activities

1. Hand out the collected labels to the class and have them determine the common types of information all labels contain. Then have them discover what additional information is found on the labels of the poisonous pesticides. What active ingredients appear to be the most hazardous? List the discoveries on the chalkboard as they are determined and have the students copy them in their notebooks.

2. Provide the students with the available pesticide catalogs, charts, etc. Then with the teacher acting as a customer, give the students problems that are common, such as;

   a. I need a fly spray to use on my dairy cows. What should I use?

   b. I have some "bugs" chewing my melons. What should I use?

   c. What do you have to keep my apples from getting scabs?

   Have them use the references available to find the answer.

   When a student finds the correct answer, have him explain to the others how he located the answer.

Suggested Instructional Materials and References

1. Labels from pesticide containers
2. Chemical company catalogs, charts, etc.
3. College of Agriculture pesticide bulletins

Suggested Occupational Experience

1. Have the students become familiar with the catalogs, charts, bulletins, etc., available at his training center so that he is able to use them correctly when dealing with customers.

2. The teacher can take the lead with the owner or manager to work out an arrangement for ready reference by sales persons if this has not been done already.

VII. To understand the methods used in merchandising agricultural chemicals

Teacher Preparation

Subject Matter Content

Advertising

Have the student collect advertisements for agricultural chemicals. Discuss with them the types of advertisements and the accuracy and effectiveness of them. Most advertising of chemicals is done by the manufacturers with:

1. Space in popular national or industry publications
2. Purchased time for radio and television advertisements
3. Fliers and pamphlets to be distributed by retail outlets
4. Mailers that are sent to consumers of agricultural chemicals
5. Window posters, banners, and displays for use in retail outlets

Retailers generally do little advertising other than using the advertising materials provided by the manufacturers or distributors of the chemicals. Larger retailers may purchase some advertisement space in local newspapers or time on radio and television, but these ads often put more emphasis on seed, fertilizers, and other items they have to sell.

Advertising must be considered a form of education. Agricultural chemicals tend to sell themselves when a customer recognizes his need through some form of education. Once the need for the chemical is understood, the advertisement informs the customer that your business can supply the product.

Size of Containers

Chemicals are sold in varying sized containers. It is possible to buy the same herbicide in 8 ounce containers at a price of $1.19 or in five gallon containers at $6.50 per gallon. This

means that the small container costs three times more per unit. This may seem unreasonable but there are justifications.

1. The small container costs more proportionally to the material it contains than does the larger container.

2. Packaging and handling costs of the small unit may nearly equal that of the larger unit.

3. It required as much time to sell a small container as to sell a large unit.

Principles of Merchandising

In merchandising chemicals there are a few important principles to keep in mind.

1. By advertising, remind customers shortly before the time it is required that you have the product they will need.

2. Display your products neatly and prominently to attract and remind customers.

3. Have the required products available at the time of demand.

4. Sell the correct chemical for the problem and advise the customers of proper use. This will improve the chances of a satisfied customer who will return.

Future Outlook

It would appear that the chemical industry will continue to be a rapidly growing industry with opportunities for many qualified young men in sales and service occupations. The industry is growing at a rate of 5-10 per cent annually with indications that this rate might accelerate.

In recent years there has been much publicity, biased and otherwise, about the indiscriminate and faulty use of pesticides, particularly insecticides. This public reaction has undoubtedly slowed the acceptance of pesticides and has been the impetus for many of the trends now developing in the industry. Some of these are:

1. Substitution of less toxic compounds for more poisonous materials. For example, the substitution of carbaryl for parathion in many cases.

2. Development of new compounds that leave less persistent residues.

3. New pest control research, resulting in

   a. Hundreds of new products

   b. Selective pesticides designed for more specific problems

   c. Systemic action pesticides

   d. New methods of pest control

      1) attractants
      2) chemosterilants to prevent reproduction
      3) antimetabolities
      4) anti-feeding compounds

4. Products that are less harmful to crops, livestock, and the beneficial biological environment

5. Development of application methods that provide better pest control with minimum hazards

The use of agricultural chemicals is as much a part of today's agriculture as the crops and livestock on which they are used. In a world with mounting food requirements, agricultural chemicals will play a major role in assisting farmers to supply the food and fiber that our people demand.

Suggested Teaching-Learning Activities

1. Have the students make an attractive display of agricultural chemicals at school or if arrangements can be made, a local retailer may permit the class to arrange a display at his business.

2. Have the students calculate the cost of various pesticides on a pint or pound comparison when purchased in various sized containers.

3. Have the students do some out-of-school research and determine the number and kind of new pesticides that have come into use in your community in the past five years.

Suggested Instructional Materials and References

Instructional materials

1. Printed advertisements for agricultural chemicals
2. Tape recording of a good and bad radio commercial for agricultural chemicals
3. Banners, posters, etc. of agricultural chemicals

References

Pesticide Handbook - Entoma. pp. 21-23.

Suggested Occupational Experience

The student should gain experience in developing and maintaining displays of agricultural chemicals at his training center.

Suggestions for Evaluating Educational Outcomes of this Module

Students should be evaluated on their ability to use effectively the content of this module. Basic recognition of types of pests, pest damage, types of pesticides, action of pesticides, methods of application, importance of agricultural chemicals, reading and understanding labels, catalogs, etc., may be evaluated by classroom testing.

However, the ability to translate this information to particular problem situations in an occupational experience situation will best measure the effectiveness of this module. The employer-cooperator should evaluate the student in these areas of competency. A form questionnaire would be valuable in measuring the competency of the students. A suggested form is on the following page.

Name of trainee_____

Name of cooperator_____

Please evaluate the trainee on his performance in these skills related to agricultural chemicals. Please check in the appropriate column.

Competency	Highly competent	Competent	Needs further training
Ability to identify parts			
Ability to identify pest damage			
Ability to recommend pesticides			
Ability to advise on application			
Ability to read and interpret labels			
Ability to use catalogs, charts, etc.			
Ability to calibrate applicators			
Ability to mix sprays accurately			
Safe work habits with chemicals			
Ability to sell chemicals			

What essential understandings, skills, and abilities does the trainee lack or need to develop further?_____

_____

Does the trainee have the attitudes and appreciations necessary to become a successful employee in the retail chemical industry?_____

_____

Source of Suggested Instructional Materials and References

Instructional materials

1. "Points about Pesticides" and "Facts about Pesticides." Colored filmstrips with 33 1/3 recordings. Order from Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, N.W., Washington D. C.

2. "The Safe Use of Pesticides," 21 minutes, color, 16 mm order from your state film library.

3. Major chemical companies have educational materials which may be appropriate for class instruction as well as for teacher or student reference. These materials are being updated continually and the companies are willing to provide them upon request.

References

1. Conover, H. S. Grounds Maintenance Handbook. Second Edition, New York: F. W. Dodge Corporation, 1958.

2. Frear, D. E. H. Pesticide Handbook - Entoma. Published annually, College Science Publishers, State College, Pennsylvania. Price: $2.50.

3. Janick, J. Horticultural Science. San Francisco, California: W. H. Freeman and Company, 1963.

4. Klingman, G. C. Weed Control: As A Science. John Wiley and Sons, Inc., 440 4th Avenue, New York.

5. Krebs, A. H. Agriculture in Our Lives. Second Edition, The Interstate Printers and Publishers, 19-27 N. Jackson, Danville, Illinois. Price: $4.40.

6. Schneider, G. W. and Scarborough, C. C. Fruit Growing. Englewood Cliffs, New Jersey: Prentice-Hall, Inc, 1960. Price: $3.95.

7. Agricultural Chemicals - What They Are: How They Are Used. Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, N. W., Washington, D. C.

8. Chemical Handbook on Economic Poisons. Publ. No. 476. Public Health Service, U. S. Department of Health, Washington, D. C.

9. Farm Chemical Handbook. Published annually, Meister Publishing Company, 37841 Euclid Avenue, Willoughby, Ohio. Price: $10.

10. U. S. D. A. Yearbooks.

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COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
_____Ornamental Horticulture--Service Occupations
_____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
_____

6. How many students:
a) Were enrolled in class (total) _____
b) Participated in studying this module _____
c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

(Date) (Instructor's Signature)

(School Address)